

NAMES \_\_\_\_\_  
Section: \_\_\_\_\_  
Physics 315  
Problem Set 3  
100 points  
Due: *Beginning of class*, Lesson 24

To receive full credit you must show all work, communicate efficiently using proper grammar, and for every short answer (e.g. yes, no, maybe, it depends, I don't know) include an explanation why. On all answers requiring calculations, **SHOW YOUR WORK**.

AUTHORIZED RESOURCES: *any published or unpublished sources and any individuals*.

Document appropriately! \_\_\_\_\_

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1. Give 5 examples of how a fighter pilot may use different portions of the electromagnetic spectrum. Include the respective frequency and wavelength.
2. Briefly describe the purpose of the following basic radar elements: transmitter, receiver, duplexer, and antenna.
3. A new and convenient (and easy to remember) value for the speed of light is in feet per nanosecond. What is this value (only use one significant digit in your answer). If we use this approximate value, to what percent will our answers be in error?
4. A “typical” fighter radar operates at about 10 GHz. How long are these waves *in cm*? Briefly explain why these waves incident upon another aircraft would be scattered and not specularly reflected (explain the two pertinent parameters and the ratio that determines whether energy is specularly or diffusely reflected).
5. If the background noise is 1 mW and the signal to noise ratio is 27 dB, what is the strength of the signal?
6. Define the term “phasor.” Given the information that modern, pulse-Doppler radars generate a signal at an extremely well-known, steady frequency and have extremely accurate clocks, and given the fact that it is much easier to analyze relatively low frequency signals than higher ones, give a rationale for our initial study of phasors.
7. What is a sideband? When modulating the amplitude of a sinusoidal signal, why are they usually created in pairs? The use of phasor diagrams should figure prominently in your answer.

8. The shorter the wavelength, the better the resolution an instrument can provide. Knowing this, explain why most radars aren't designed to operate much above 10 GHz (hint: the atmosphere has a huge influence on this parameter, as does the fact that the radar must fit in a fighter's nose).

9. What is a radar sidelobe? What physical process causes them? Why do we try to minimize them? Be brief!

10. The term resolution cell (res cell) is a critical tactical parameter for any radar. It is related to the width of the main lobe of the radar and the length of the radar pulse at some given range. Two aircraft flying within a res cell will be displayed as a single target by the radar. Given a pulse width of 400 ns, estimate the size of the resolution cell of the F-15's radar at 20 NM. Your answer should be expressed something like "The Eagle's res cell at 20 Nautical Miles is XX feet in elevation, XX feet in azimuth, and XX feet in range." Be sure to clearly list your assumptions required to make these calculations.